Report Documentation Page					*Form Approved* *OMB No. 0704-0188*

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1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **High Frequency Bottom Interaction Acoustics in the Atlantic Natural Laboratory**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Woods Hole Oceanographic Institution,Woods Hole,MA,02543**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S) 11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**2**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

High Frequency Bottom Interaction Acoustics in the Atlantic Natural Laboratory

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Category of Research: High Frequency Acoustics

LONG TERM GOALS

The long term objectives of this project are: 1) to develop a numerical technique capable of predicting the low frequency acoustic wavefield scattered from geologically realistic models of the bottom/sub-bottom environment; 2) to isolate from the scattering models the physical mechanisms which dominate the long-range reverberation from the seafloor; and 3) to characterize the variations in bottom topography and sub-bottom properties that control the scattering of low frequency acoustic waves.

OBJECTIVES

Our goal is to identify the geological features on the seafloor that are responsible for strong, low grazing angle, monostatic, backscatter and to determine the physical scattering processes associated with these geological features.

APPROACH

We have chosen initially to look at the match filtered traces of the broadband LFM sweeps from the Acoustic Reverberation SRP 1993 Acoustics. The method and results are discussed in detail by Greaves and Stephen (1997). The modeling is constrained by the geological data sets acquired in and around Site ‘A’. Based on the geological data sets we prepare models of elastic parameters and density that we can use in our Numerical Scattering Chamber (NSC). The NSC predicts the monostatic backscatter that we would expect from a given model and this is turn is compared with the actual acoustic returns from the geological area.

WORK COMPLETED

We have completed a thorough synthesis of all of the geological data sets acquired in and around Site ’A’ and we have constructed a number of seafloor models based on the geological descriptions. A large suite of models addressing specific features of the seafloor have been run. This work has been written up as a chapter for R. Greaves PhD thesis.

RESULTS

At the 200m scale we have not been able to identify a clear correlation between true dip and backscatter. Our direct analysis of the data does not confirm Lambert's Law. There is so much variability in the intensity-dip relation that the precise functional relationship is not well defined. A linear relationship fits as well as any. In addition there are no quantifiable differences in scattering from "inside" and "outside" corner crust. One conclusion is that the physical mechanisms responsible for low angle, monostatic backscatter must occur at scales less than the hydrosweep bathymetry (200m) and/or by volume (from below the seafloor) rather than interface (seafloor) scattering.

IMPACT ON SCIENCE AND TECHNOLOGY

One product of this study is a test of Lambert's Law for low angle backscatter from the seafloor. Although Lambert's Law may work to explain observations, other functional relationships could work just as well. By considering the different geological provinces of the seafloor in more detail we hope to provide a more accurate representation of back scattering than is currently being used in the fleet and at some Navy labs. Previous modeling studies suggest that there should be a small scale (20m) deterministic component to the backscatter data. The techniques developed in this work and the insights gained into scattering mechanisms will apply to a broad range of environments (including deep and shallow water and sedimentary and igneous bottoms) and over a broad range of frequencies (from 10Hz to over 100kHz).

TRANSITIONS

RELATED PROJECTS

REFERENCES

Greaves, R.J. and Stephen, R.A. (**1997**). "Seafloor acoustic backscattering from different geological provinces in the Atlantic Natural Laboratory," J. Acoust. Soc. Am.